



The Pennsylvania System of School Assessment

Science Item and Scoring Sampler



2008–2009
Grade 11

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SCIENCE

INTRODUCTION

General Introduction

The Department of Education provides districts and schools with tools to assist in delivering focused instructional programs aligned to the state assessment system. These tools include assessment anchor documents, assessment handbooks, and content-based item and scoring samplers. This 2008–2009 Science Item and Scoring Sampler is a useful tool for Pennsylvania educators in the preparation of local instructional programs and the statewide Pennsylvania System of School Assessment (PSSA).

What Is Included

The 2008–2009 Science Item and Scoring Samplers do not contain newly released items. The samplers are a reproduction of previously released items. This item and scoring sampler contains science multiple-choice and open-ended items, some of which are organized in a science scenario. These items are examples of science items that may be used to assess student performance on the PSSA. These items provide an idea of the types of items that will appear on the operational Spring 2009 PSSA. Each item has been through a rigorous review process to ensure alignment with the Assessment Anchors.

Purpose and Uses

The items in this sampler may be used as examples for creating assessment items at the classroom level, and they may also be copied and used as part of a local instructional program.* Classroom teachers may find it beneficial to have students respond to the open-ended items in the sampler. Educators can then use the sampler as a guide to score the responses either independently or together with colleagues within a school or district.

Item Format and Scoring Guidelines

The multiple-choice items have four answer choices. Each correct response to a multiple-choice item is worth one point.

Each short open-ended (SOE) item is designed to take about ten minutes to complete. Each extended open-ended (EOE) item is designed to take about twenty minutes to complete. During an official testing administration, students are given additional time as necessary to complete the test items. Each open-ended item in science is scored using an item-specific scoring guideline based on either a 0–2 or a 0–4 point scale. In this sampler, every item-specific scoring guideline is combined with examples of student responses representing each score point to form a practical item-specific scoring guide.

The sampler also includes the General 2-Point and 4-Point Scoring Guidelines for Science used to develop the item-specific guidelines and guides. The General Scoring Guidelines should be used if any additional item-specific scoring guidelines are created for use within local instructional programs.*

The science scenario presents a topic or common theme that is explored by four multiple-choice items and one extended open-ended item.

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SCIENCE

GENERAL 2-POINT SCORING GUIDELINES FOR SCIENCE

- 2 – The response demonstrates a *thorough* understanding of the scientific content, concepts, and procedures required by the task(s).**

The response provides a clear, complete, and correct response as required by the task(s). The response may contain a minor blemish or omission in work or explanation that does not detract from demonstrating a *thorough* understanding.

- 1 – The response demonstrates a *partial* understanding of the scientific content, concepts, and procedures required by the task(s).**

The response is somewhat correct with *partial* understanding of the required scientific content, concepts, and/or procedures demonstrated and/or explained. The response may contain some work that is incomplete or unclear.

- 0 – The response provides *insufficient* evidence to demonstrate any understanding of the scientific content, concepts, and procedures as required by the task(s) for that grade level.**

The response may show only information copied or rephrased from the question or *insufficient* correct information to receive a score of 1.

Special categories within zero reported separately:

BLK (blank) – No response or written refusal to respond or too brief to determine response

OT – Off task/topic

LOE – Response in a language other than English

IL – Illegible

SCIENCE

GENERAL 4-POINT SCORING GUIDELINES FOR SCIENCE

- 4 – The response demonstrates a *thorough* understanding of the scientific content, concepts, and procedures required by the task(s).**

The response scores two points for each assigned task. The response for each task provides a clear, complete, and correct response as required by the task. The response may contain a minor blemish (e.g., misspelled words) or omission in work or explanation that does not detract from demonstrating a *thorough* understanding.

NOTE: Refer to the General Description of 2-Point Science Scoring Guidelines on page 2 for a full description of how each 2-point task is scored.

- 3 – The response demonstrates a *general* understanding of the scientific content, concepts, and procedures required by the task(s).**

The response scores two points for one assigned task and one point for the other assigned task.

- 2 – The response demonstrates a *partial* understanding of the scientific content, concepts, and procedures required by the task(s).**

The response scores two points for one of the assigned tasks or one point for each of the assigned tasks.

- 1 – The response demonstrates a *minimal* understanding of the scientific content, concepts, and procedures as required by the task(s).**

The response scores one point for one of the assigned tasks, but no points for the other assigned task.

- 0 – The response provides *insufficient* evidence to demonstrate any understanding of the scientific content, concepts, and procedures as required by the task(s) for that grade level.**

The response scores no points for either of the assigned tasks.

Special categories within zero reported separately:

BLK (blank) – No response or written refusal to respond or too brief to determine response

OT – Off task/topic

LOE – Response in a language other than English

IL – Illegible

SCIENCE

SCIENCE REPORTING CATEGORIES

Science scores are reported in four categories:

- A – The Nature of Science
- B – Biological Sciences
- C – Physical Sciences
- D – Earth and Space Sciences

DESCRIPTION OF SAMPLE ITEMS

The science stand-alone multiple-choice items begin on page 5. Each item is preceded by the Assessment Anchor and Eligible Content coding. Answer options A–D are followed by a brief analysis or rationale of each option. The correct multiple-choice answer is indicated by an asterisk (*) in the item and labeled as “Key” in the analysis.

Stand-alone 2-point SOE items follow the multiple-choice items. Each SOE item includes an item-specific scoring guideline and samples of responses with scores and annotations.

One science scenario follows the stand-alone items; it is composed of four multiple-choice items and one 4-point EOE item. These items are all related to the scenario. The EOE item includes an item-specific scoring guide and samples of responses with scores and annotations.

DESCRIPTION OF SCIENCE SCENARIOS

Included in this sampler are multiple-choice questions and an open-ended question associated with a science scenario. Scenarios utilize content-rich stimuli and are specifically aligned to the Pennsylvania educator-developed Eligible Content. The science scenario may cover several pages and may contain text, graphics, charts, and/or tables, and may use these elements to describe the results of a class project, an experiment, or other similar research. Science scenarios address connections between multidisciplinary and interdisciplinary content domains (e.g., creating stronger connections between The Nature of Science and other science content).

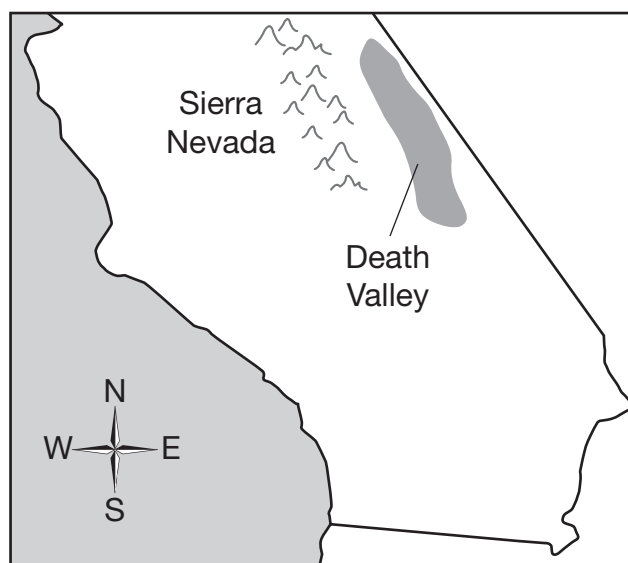
When answering the items associated with scenario stimuli, students are required to use their content knowledge and science process skills. That is, some of the scenario items require that students use content knowledge to answer content-based questions, and other scenario items require that students process pertinent information from the scenario to answer questions.

SCIENCE

MULTIPLE-CHOICE ITEMS

D.2.1.3

Use the map below to answer question 1.



1. Death Valley, one of the driest places on Earth, is located on the eastern side of the Sierra Nevada mountain range. Which statement correctly explains why the east side of these mountains is so much drier than the west side?
- A Since weather systems generally move from east to west in the United States, as an air mass reaches the mountains, it rises and cools, and its moisture condenses and precipitates.
 - B Since weather systems generally move from east to west in the United States, as an air mass reaches the mountains, it rises and warms, and its moisture evaporates and precipitates.
 - C Since weather systems generally move from west to east in the United States, as an air mass reaches the mountains, it rises and cools, and its moisture condenses and precipitates. *
 - D Since weather systems generally move from west to east in the United States, as an air mass reaches the mountains, it rises and warms, and its moisture evaporates and precipitates.

- A *Weather systems generally move from west to east.*
- B *Weather systems generally move from west to east; the air cools as it ascends the side of the mountain range, and the moisture in the air condenses.*
- C *Key: This is the correct explanation.*
- D *The air cools as it ascends the side of the mountain range, and the moisture in the air condenses.*

SCIENCE

C.1.1.6

2. When silver nitrate solution is added to salt water, a reaction occurs and a milky white precipitate forms. Which statement correctly describes how the rate of this reaction can be influenced?
- A An increase in the temperature of the salt water will increase the frequency and energy of collisions. *
 - B A decrease in the temperature of the silver nitrate will increase the frequency and energy of collisions.
 - C An increase in the volume of salt water will increase the frequency and energy of collisions.
 - D A decrease in the volume of silver nitrate will increase the frequency and energy of collisions.

- A *Key: Increasing the temperature would increase the rate of the reaction.*
- B *Decreasing the temperature would decrease the rate of reaction.*
- C *Increasing the amount of salt water would not affect the frequency and energy of collisions.*
- D *Decreasing the amount of silver nitrate would not increase the frequency and energy of collisions.*

B.2.2.2

3. If an organism is known to have 38 chromosomes in each body cell, how many chromosomes will each new gamete have after meiosis?
- A 2 chromosomes
 - B 19 chromosomes *
 - C 38 chromosomes
 - D 76 chromosomes

- A *Two is not half of 38; 38 is divided by 2 during meiosis.*
- B *Key: Meiosis is a reduction process; it produces daughter cells with half the number of chromosomes as the parent cells ($38 \div 2 = 19$).*
- C *This (38) represents the number of chromosomes in the parent cells.*
- D *This (76) is double the number of chromosomes in the parent cells.*

SCIENCE

A.2.2.1

4. A student must determine the density of an irregularly shaped metal object. Which combination of equipment and method would provide the **best** quantitative observations?
- A Find the mass with a balance, find the volume by linear measure, and then calculate the density.
 - B Find the mass with a balance, find the volume by linear measure, and then calculate the average density of several trials.
 - C Find the mass with a balance, find the volume by water displacement, and then calculate the density.
 - D Find the mass with a balance, find the volume by water displacement, and then calculate the average density of several trials. *

- A *Linear measure is not used for an irregular shape.*
- B *Linear measure is not used for an irregular shape.*
- C *Averaging several trials would yield the best observations.*
- D *Key: This is the best procedure and averaging several trials will give the best (most reliable) quantitative observations.*

B.3.3.1

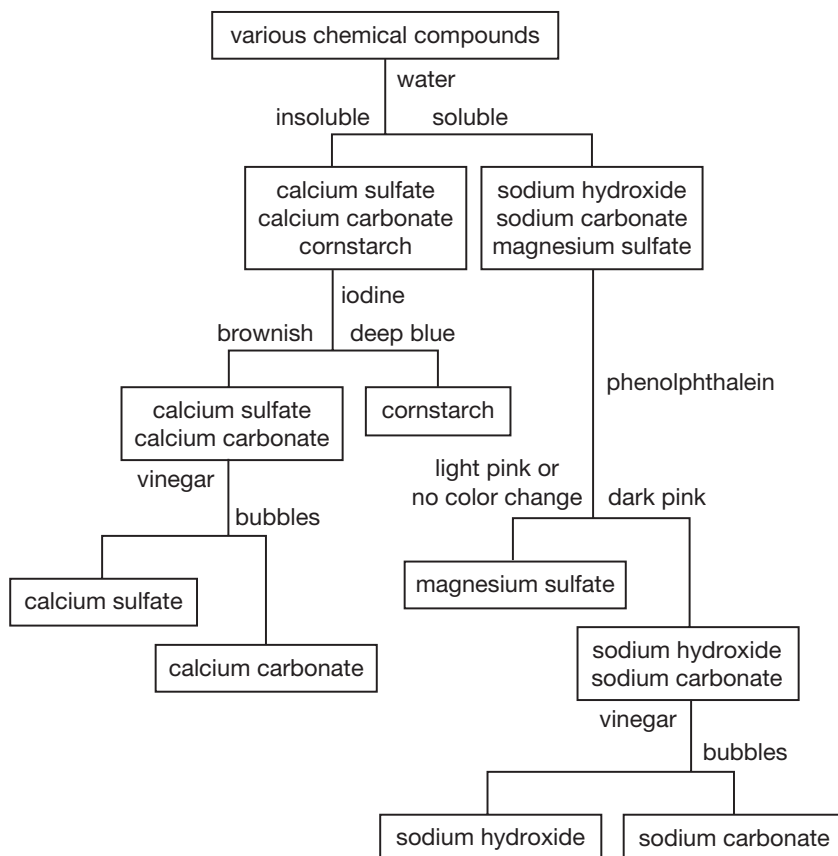
5. Which system uses a nonrenewable resource to generate electricity?
- A wind turbines using air movement
 - B solar panels using the Sun's radiation
 - C geothermal power plants using steam
 - D nuclear power plants using radioactive elements *

- A *Wind is considered to be a renewable energy resource because the source (moving air) is constant.*
- B *Solar radiation is considered to be a renewable energy resource because the source (the Sun) is constant.*
- C *Geothermal is considered to be a renewable energy resource because the source (geothermal heat) is constant.*
- D *Key: Nuclear energy is considered to be nonrenewable because the fuel/source (uranium-235) is limited in supply.*

SCIENCE

A.3.1.1

Use the flow chart below to answer question 6.



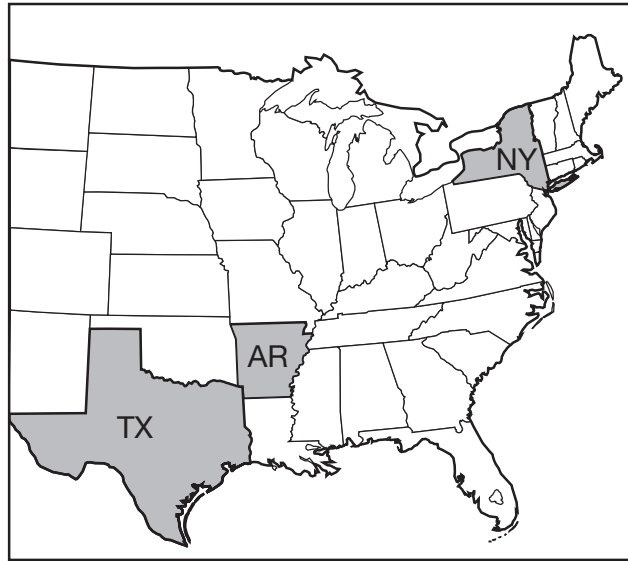
6. Which substance does not dissolve when mixed with water, changes color in the presence of an indicator, and reacts with vinegar?
- A cornstarch
 - B calcium carbonate *
 - C sodium carbonate
 - D sodium hydroxide

- A Cornstarch is insoluble in water, and changes color in the presence of an indicator, but the chart does not indicate if it reacts with vinegar.
- B Key: Calcium carbonate is insoluble in water, changes color in the presence of an indicator, and bubbles when mixed with vinegar.
- C Sodium carbonate is soluble in water, does not change color in the presence of the indicators used on the chart, but it does bubble when mixed with vinegar.
- D Sodium hydroxide is soluble in water.

SCIENCE

B.2.1.3

Use the the map below to answer question 7.



7. An agricultural scientist selectively bred blackberry plants adapted to conditions in southern Texas with plants adapted to conditions in western New York. This cross produced plants that were adapted for conditions in Arkansas. The plants' suitability for conditions in Arkansas was the result of which characteristic of the offspring plants?
- A having some genetic material from each of the parent plants *
 - B having all of the characteristics of each of the parent plants
 - C having inherited behavioral adaptations for both northern and southern climates
 - D having equal suitability to climates found throughout the United States

- A *Key: Selective breeding allows researchers to combine the characteristics of different types of plants by producing offspring that share their genetic material.*
- B *An offspring plant cannot carry all of the characteristics of each parent plant.*
- C *An offspring plant does not inherit behavioral adaptations.*
- D *The data do not indicate that the plants are suited to climate throughout the United States.*

SCIENCE

C.2.1.4

8. A student designs a circuit that has a battery, a resistor, and a light bulb connected in series. Which two changes could be made to the circuit so that each would contribute to a brighter glow from the light bulb?
- A decrease the voltage and decrease the resistance
 - B decrease the voltage and increase the resistance
 - C increase the voltage and decrease the resistance *
 - D increase the voltage and increase the resistance

- A *Decreasing the voltage would cause the light bulb to dim.*
- B *Increasing the resistance would cause the light bulb to dim.*
- C *Key: Both of these would cause the light bulb to glow more brightly.*
- D *Increasing the resistance would cause the light bulb to dim.*

A.1.1.1

9. Which statement **best** compares scientific theories with scientific laws?
- A Both theories and laws are important steps in the scientific method.
 - B Both theories and laws are irrefutable and final descriptions of nature.
 - C Both theories and laws are accepted to be true but are often refuted by new evidence.
 - D Both theories and laws are accepted to be true and can be used to make predictions. *

- A *The parts of the scientific method include observation, hypothesis, and experimentation.*
- B *Theories and laws are subject to alteration with new information.*
- C *Theories and laws can be refuted, but this statement is not the best comparison.*
- D *Key: In general, both scientific theories and scientific laws are accepted to be true by the scientific community as a whole. Both are used to make predictions of events.*

SCIENCE

B.2.1.2

Use the table below to answer question 10.

Shell Color in Theoretical Insect Population

Year	Amount of Population with Specific Shell Color (%)	
	Yellow	Brown
1	75	25
2	50	50
3	25	75
4	100	0

10. This table shows changes in the occurrence of different shell colors in a theoretical population of insects over a four-year period. How could differential reproduction explain the changes in the insects' shell color over the four-year period?
- A Changing circumstances made brown-shelled insects more attractive to potential mates.
 - B Chemical changes in the insects' shells made brown-shelled insects reproduce more rapidly.
 - C Chemical changes in the insects' DNA made brown-shelled insects reproduce at a higher rate.
 - D Changing circumstances made brown-shelled insects less likely to survive to reproductive age. *

- A *Differential reproduction does not address attractiveness of mates.*
- B *Differential reproduction does not address rate of reproduction.*
- C *Differential reproduction does not explain responses to mutations.*
- D *Key: Differential reproduction is defined as the increased likelihood of the fittest organisms surviving long enough to reproduce.*

SCIENCE

FIRST OPEN-ENDED ITEM

B.3.2.3

This is a short open-ended (SOE) question. It is worth two points.

11. A farmer plants corn one spring and harvests the corn in the fall. The farmer does not plant corn or any other crop in the field again.

Describe two ways that the field will change over time.

SCIENCE

ITEM-SPECIFIC SCORING GUIDELINE

Item #11

This item will be reported under Category B, Biological Sciences

Assessment Anchor:

B.3.2 Analyze patterns of change in natural or human-made systems over time.

Specific Eligible Content addressed by this item:

B.3.2.3 Explain how natural processes (e.g., seasonal change, catastrophic events, habitat alterations) impact the environment over time.

Scoring Guide:

Describe two ways the field will change over time.

Score	In this item, the student—
2	demonstrates a <i>thorough</i> understanding of succession by describing two changes that would naturally occur in an abandoned field over time. The response is clear, complete, and correct.
1	demonstrates a <i>partial</i> understanding of succession by describing one change that would naturally occur in an abandoned field over time. The response may contain some work that is incomplete or unclear.
0	provides <i>insufficient</i> evidence to demonstrate any understanding of the content being tested.
Non-scorable	BLK (blank) – No response or written refusal to respond or response too brief to determine response OT – Off task/topic LOE – Response in a language other than English IL – Illegible

Note: No deductions should be taken for misspelled words or grammatical errors.

SCIENCE

OPEN-ENDED ITEM RESPONSES

Response Score: 2

B.3.2.3

This is a short open-ended (SOE) question. It is worth two points.

11. A farmer plants corn one spring and harvests the corn in the fall. The farmer does not plant corn or any other crop in the field again.

Describe two ways that the field will change over time.

1. The field will be taken over by mixed plant species that includes corn and weeds.

2. Small trees and bushes would be growing in the field after many years. Animals that live in the trees would move in too.

The student response correctly describes two changes that will occur in the field over time.

SCIENCE

Response Score: 1

B.3.2.3

This is a short open-ended (SOE) question. It is worth two points.

11. A farmer plants corn one spring and harvests the corn in the fall. The farmer does not plant corn or any other crop in the field again.

Describe two ways that the field will change over time.

Stubble from the corn that remains after the fall harvest will catch snow that will increase the moisture content in the soil. The stubble will slowly decay, and this will provide insulation as long as some stubble remains.

The student response includes only one correct description of changes due to stubble that will occur in the field over time. The student did not describe a second way the field will change over time.

SCIENCE

Response Score: 0

B.3.2.3

This is a short open-ended (SOE) question. It is worth two points.

11. A farmer plants corn one spring and harvests the corn in the fall. The farmer does not plant corn or any other crop in the field again.

Describe two ways that the field will change over time.

If the farmer does not replant, the field will not support plant or animal life.

The student response is incorrect.

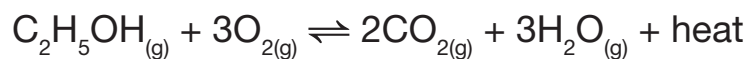
SCIENCE

SECOND OPEN-ENDED ITEM

A.1.3.2

This is a short open-ended (SOE) question. It is worth two points.

Use the chemical equation below to answer question 12.



12. The chemical reaction described above occurs in a closed cylinder. Describe two ways to increase the concentration of carbon dioxide (CO_2) by changing the conditions in the cylinder.

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SCIENCE

ITEM-SPECIFIC SCORING GUIDELINE

Item #12

This item will be reported under Category A, The Nature of Science

Assessment Anchor:

A.1.3 Describe and interpret patterns of change in natural and human-made systems.

Specific Eligible Content addressed by this item:

A.1.3.2 Describe or interpret dynamic changes to stable systems (e.g., chemical reactions, human body, food webs, tectonics, homeostasis).

Scoring Guide:

Describe two ways to increase the concentration of carbon dioxide (CO_2) by changing the conditions in the cylinder.

Score	In this item, the student—
2	demonstrates a <i>thorough</i> understanding of relationships in systems and predicting changes to stable systems by correctly describing two things that would increase the carbon dioxide (CO_2) concentration in this system. The response is clear, complete, and correct.
1	demonstrates a <i>partial</i> understanding of relationships in systems and predicting changes to stable systems by correctly describing one thing that would increase the carbon dioxide (CO_2) concentration in this system. The response may contain some work that is incomplete or unclear.
0	provides <i>insufficient</i> evidence to demonstrate any understanding of the content being tested.
Non-scorable	BLK (blank) – No response or written refusal to respond or response too brief to determine response OT – Off task/topic LOE – Response in a language other than English IL – Illegible

Note: No deductions should be taken for misspelled words or grammatical errors.

SCIENCE

OPEN-ENDED ITEM RESPONSES

Response Score: 2

A.1.3.2

This is a short open-ended (SOE) question. It is worth two points.

Use the chemical equation below to answer question 12.



12. The chemical reaction described above occurs in a closed cylinder. Describe two ways to increase the concentration of carbon dioxide (CO_2) by changing the conditions in the cylinder.

1. Increase the amount of O_2 .

2. Increase the volume in the cylinder.

The student response correctly describes two ways to increase the concentration of carbon dioxide (CO_2) in this system.

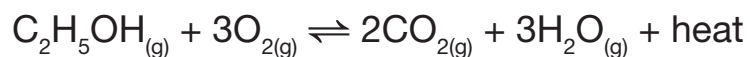
SCIENCE

Response Score: 1

A.1.3.2

This is a short open-ended (SOE) question. It is worth two points.

Use the chemical equation below to answer question 12.



12. The chemical reaction described above occurs in a closed cylinder. Describe two ways to increase the concentration of carbon dioxide (CO_2) by changing the conditions in the cylinder.

_____ Increase the amount of O_2 gas. _____

The student response correctly describes only one way to increase the concentration of carbon dioxide (CO_2) in this system.

SCIENCE

Response Score: 0

A.1.3.2

This is a short open-ended (SOE) question. It is worth two points.

Use the chemical equation below to answer question 12.



12. The chemical reaction described above occurs in a closed cylinder. Describe two ways to increase the concentration of carbon dioxide (CO_2) by changing the conditions in the cylinder.

Add heat to the system.

The student response is incorrect.

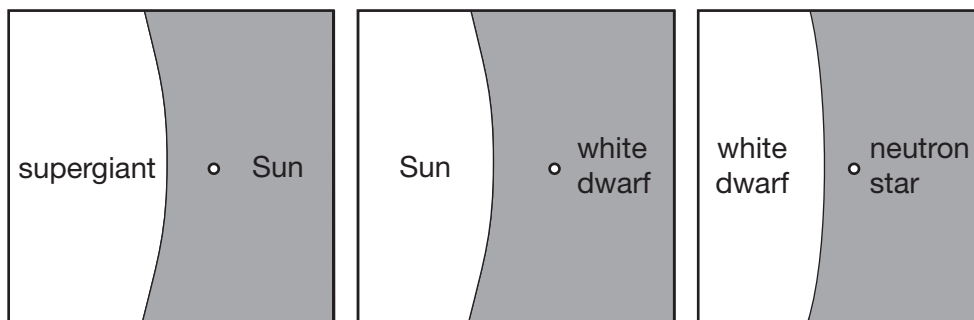
SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

The high school astronomy club visited a local university's observatory to learn more about how the life cycle of stars and the formation of the universe are investigated. At the observatory, a team of scientists was collecting hydrogen spectrographic data on many distant stars and galaxies. The scientists used data from several telescopes, including the Keck Telescopes in Hawaii and the Hubble Space Telescope that orbits Earth. These telescopes are used to observe very distant objects. The scientists also used data from the university's more limited telescope, which is used to observe closer objects.

At the observatory, the students also learned about the relative size of star types. Some of that information is shown below.

Size Comparisons of Stars

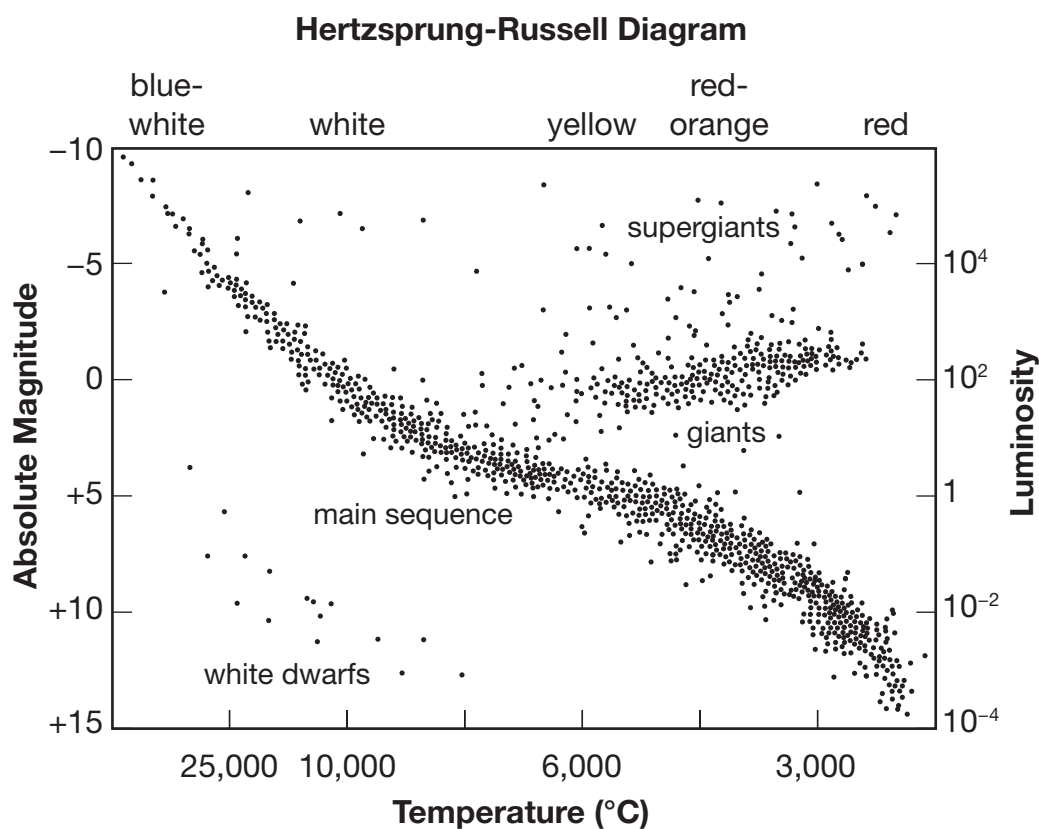


Object	Mass (kg)	Radius (km)
Earth	5.98×10^{24}	6.37×10^3
Sun	1.989×10^{30}	6.96×10^5
an average red giant	1.591×10^{30}	6.96×10^7
an average white dwarf	1.0×10^{30}	5.0×10^3
an average neutron star	2.0×10^{30}	1.0×10^1

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

The students also learned how the size, color, luminosity, and absolute magnitude of stars are related. The Hertzsprung-Russell diagram compares characteristics of star types. Each dot on the diagram represents a star whose characteristics have been determined. Notice that the data appear to clump naturally into four star groups: white dwarfs, main sequence, giants, and supergiants.



SCIENCE SCENARIO

MULTIPLE-CHOICE ITEMS

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

A.2.2.2

13. Which statement explains why the team of scientists at the observatory **most likely** used other telescopes to gather light emission spectra data from stellar objects?

- A Hubble and Keck are in different locations so scientists can see galaxies from different angles.
- B Hubble and Keck are closer to the objects being observed so these objects are easier to find.
- C Hubble and Keck are less affected by Earth's atmosphere so scientists can see distant galaxies more clearly. *
- D Hubble and Keck are less costly to use so scientists can use them for longer periods of time.

- A *This (the angle) would not affect light emission data collection.*
- B *Whether an object is easy to find does not affect light emission data collection.*
- C *Key: Because the data being collected are light emissions, telescopes that are farthest from Earth's atmosphere are least affected by atmospheric conditions; they will produce the clearest images (data).*
- D *Cost of use might be a consideration, but it does not directly affect the mechanics of collecting light emission data.*

D.3.1.2

14. Which statement correctly describes how a star uses fuel to generate heat and light energy?

- A In a protostar, hydrogen atoms combine to form oxygen.
- B In a main sequence star, helium atoms combine to form hydrogen.
- C In a white dwarf star, heavy atoms break apart to form smaller atoms.
- D In a supergiant star, smaller atoms fuse together to form heavier atoms. *

- A *In a protostar, hydrogen fuses to make helium.*
- B *In a main sequence star, hydrogen fuses to make helium.*
- C *In a white dwarf star, all of the helium has fused into carbon, and the core collapses.*
- D *Key: In a supergiant star, fusion forms heavier and heavier elements, and eventually the core is converted to iron.*

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

A.2.1.3

15. Which relationship between red giants and white dwarfs is a correct inference?

- A The smaller the star, the brighter it appears.
- B The larger the star, the dimmer it appears.
- C The higher the density, the higher the temperature. *
- D The higher the density, the lower the temperature.

- A *According to the information presented, smaller stars (white dwarfs) are less bright.*
- B *According to the information presented, larger stars (red giants) have greater luminosities.*
- C *Key: According to the information presented, stars that are most dense (white dwarfs) have the highest temperatures.*
- D *According to the information presented, stars that are most dense (white dwarfs) have the highest temperatures.*

D.3.1.2

16. Which statement correctly describes the structure of the Sun under its visible surface?

- A The Sun is composed entirely of gases and has no discernable structure.
- B The Sun is composed entirely of gases and has a thin outer convection layer, a large radiant middle layer, and a small dense core. *
- C The Sun has a thin liquid outer layer, a gaseous layer, and a large solid core.
- D The Sun has a large convection layer of swirling gases and a small dense solid core.

- A *The Sun has structure.*
- B *Key: This is a correct description of the Sun.*
- C *The Sun does not have a liquid layer or a solid core.*
- D *The Sun has more than two layers and it does not have a solid core.*

SCIENCE SCENARIO

OPEN-ENDED ITEM

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

A.1.3.1

This is an open-ended question with two parts. Each part is worth two points.

17. A red giant, which developed from a main sequence star that had a mass similar to that of the Sun, evolves into a white dwarf.

Part A: Describe quantitatively how two physical characteristics of this stellar object, other than color, changed during its evolution from a red giant to a white dwarf.

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

Response Score:

D.3.1.2

This is an open-ended question with two parts. Each part is worth two points.

17. *Continued.*

Part B: Describe the steps leading to the formation of the Sun from a cool hydrogen cloud as suggested by the solar nebula theory. Be sure to identify the type of reaction that generates the energy that helps define certain celestial objects as stars.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

SCIENCE SCENARIO

OPEN-ENDED SCORING GUIDELINE

Item #17A

This item will be reported under Category A, The Nature of Science

Assessment Anchor:

A.1.3 Describe and interpret patterns of change in natural and human-made systems.

Specific Eligible Content addressed by this item:

A.1.3.1 Use appropriate quantitative data to describe or interpret change in systems (e.g., biological indices, electrical circuit data, automobile diagnostic systems data).

Scoring Guide:

Part A: Describe quantitatively how two physical characteristics of this stellar object, other than color, changed during its evolution from a red giant to a white dwarf.

Score	In this item, the student—
2	demonstrates a <i>thorough</i> understanding of the use of appropriate quantitative data to describe or interpret change in systems by using the appropriate information from that presented to correctly describe quantitatively how two physical characteristics of this stellar object changed during its evolution. The response is clear, complete, and correct.
1	demonstrates a <i>partial</i> understanding of the use of appropriate quantitative data to describe or interpret change in systems by using the appropriate information from that presented to correctly describe quantitatively how one physical characteristic of this stellar object changed during its evolution. The response may contain some work that is incomplete or unclear.
0	provides <i>insufficient</i> evidence to demonstrate any understanding of the content being tested.
Non-scorable	BLK (blank) – No response or written refusal to respond or response too brief to determine response OT – Off task/topic LOE – Response in a language other than English IL – Illegible

Note: No deductions should be taken for misspelled words or grammatical errors.

SCIENCE SCENARIO

OPEN-ENDED SCORING GUIDELINE

Item #17B

This item will be reported under Category D, Earth and Space Sciences

Assessment Anchor:

D.3.1 Explain the composition, structure, and origin of the universe.

Specific Eligible Content addressed by this item:

D.3.1.2 Describe the structure, formation, and life cycle of stars.

Scoring Guide:

Part B: Describe the steps leading to the formation of the Sun from a cool hydrogen cloud as suggested by the solar nebula theory. Be sure to identify the type of reaction that generates the energy that helps define certain celestial objects as stars.

Score	In this item, the student—
2	demonstrates a <i>thorough</i> understanding of the current scientific theories of the origin of the solar system and the universe by describing the steps leading to the formation of the Sun as suggested by the solar nebula theory, and identifying the type of reaction that defines celestial objects as stars. The response is clear, complete, and correct.
1	demonstrates a <i>partial</i> understanding of the current scientific theories of the origin of the solar system and the universe by describing the steps leading to the formation of the Sun as suggested by the solar nebula theory, or identifying the type of reaction that defines celestial objects as stars. The response may contain some work that is incomplete or unclear.
0	provides <i>insufficient</i> evidence to demonstrate any understanding of the content being tested.
Non-scorable	BLK (blank) – No response or written refusal to respond or response too brief to determine response OT – Off task/topic LOE – Response in a language other than English IL – Illegible

Note: No deductions should be taken for misspelled words or grammatical errors.

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

Response Score: 2

A.1.3.1

This is an open-ended question with two parts. Each part is worth two points.

17. A red giant, which developed from a main sequence star that had a mass similar to that of the Sun, evolves into a white dwarf.

Part A: Describe quantitatively how two physical characteristics of this stellar object, other than color, changed during its evolution from a red giant to a white dwarf.

① Temperature — The surface temperature of a white dwarf would be approximately 3 times that of a red giant.

② Size — A white dwarf would be approximately 10,000 times smaller than a red giant.

The student response to part A correctly describes (quantitatively) two physical characteristics that change during the evolution from a red giant into a white dwarf.

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

Response Score: 2

D.3.1.2

This is an open-ended question with two parts. Each part is worth two points.

17. *Continued.* Use the information on the previous page to answer part B below.

Part B: Describe the steps leading to the formation of the Sun from a cool hydrogen cloud as suggested by the solar nebula theory. Be sure to identify the type of reaction that generates the energy that helps define certain celestial objects as stars.

Star formation begins when clouds of interstellar dust begin to collapse and grow under their own weight and gravity. Over time, the clouds develop into a protostar which continually increases in mass. Eventually, it shrinks and its density increases while its temperature begins to rise. Temperature will continue to rise as the protostar enters the main sequence star phase. At this stage, it becomes a full-fledged star with a core temperature hot enough to start nuclear reactions in the core. Hydrogen fusing into helium produces large quantities of heat and light, such as our Sun.

The student response to part B correctly describes the formation of the Sun according to the solar nebula theory.

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

Response Score: 1

A.1.3.1

This is an open-ended question with two parts. Each part is worth two points.

17. A red giant, which developed from a main sequence star that had a mass similar to that of the Sun, evolves into a white dwarf.

Part A: Describe quantitatively how two physical characteristics of this stellar object, other than color, changed during its evolution from a red giant to a white dwarf.

Luminosity - The luminosity of a white dwarf would be nearly as much as 100,000 times less than that of a red dwarf.

The student response to part A is partially correct. It describes (quantitatively) one physical characteristic that changes during the evolution from a red giant into a white dwarf.

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

Response Score: 1

D.3.1.2

This is an open-ended question with two parts. Each part is worth two points.

17. *Continued.* Use the information on the previous page to answer part B below.

Part B: Describe the steps leading to the formation of the Sun from a cool hydrogen cloud as suggested by the solar nebula theory. Be sure to identify the type of reaction that generates the energy that helps define certain celestial objects as stars.

The solar nebula (stellar nursery) becomes gravitationally unstable and collapses. As it collapses the center is compressed and the temperature increases.

The student response to part B is partially correct; the student does not identify the type of reaction that generates the energy.

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

Response Score: 0

A.1.3.1

This is an open-ended question with two parts. Each part is worth two points.

17. A red giant, which developed from a main sequence star that had a mass similar to that of the Sun, evolves into a white dwarf.

Part A: Describe quantitatively how two physical characteristics of this stellar object, other than color, changed during its evolution from a red giant to a white dwarf.

The red giant gets smaller.

The student response to part A does not quantitatively describe the change that occurs during this evolution.

SCIENCE SCENARIO

Directions: Use the information presented on pages 22 and 23 to answer questions 13 through 17.

Response Score: 0

D.3.1.2

This is an open-ended question with two parts. Each part is worth two points.

17. *Continued.* Use the information on the previous page to answer part B below.

Part B: Describe the steps leading to the formation of the Sun from a cool hydrogen cloud as suggested by the solar nebula theory. Be sure to identify the type of reaction that generates the energy that helps define certain celestial objects as stars.

A big bang occurs and
a star is born.

The student response to part B is incorrect.

**Science
Grade 11
Item and Scoring Sampler**

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